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TECHNICAL REPORT RD-82-8

A TECHNICAL VIEW OF COST/SCHEDULE CONTROL
SYSTEM CRITERIA

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December 1981



U.S. ARMY MISSILE COMMAND

Redstone Arsenal, Alabama

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I. INTRODUCTION

The Cost/Schedule Control System Criteria (C/S CSC) is a system used to gage a contractor's internal management system. The criteria have two primary purposes: they impose a well-defined methodology on the contractor for establishing and monitoring his internal management and company operations; also, they provide the Government with a consistent set of rules by which data can be compared and performance judgments can be applied. This system does not impose any particular method of implementing cost and performance controls. In most cases the contractor's present system, with minor modifications, will satisfy the criteria.

This paper is written to bring an engineer's technical view to C/S CSC. It is the author's belief that the technical aspects of C/S CSC for technical management have been greatly neglected; the fiscal aspects are emphasized. If a survey were taken in most project offices, the technical and engineering personnel would be unaware of what potential benefit C/S CSC could be to them, or possibly, even what the system is.

Project engineering personnel can derive great insight into the happenings of their areas of responsibility if they take time to learn what the system is and how to use it, and if the data is available to them in a timely manner.

II. AUTHORITY AND GUIDANCE

Authority for the Department of Defense (DOD) implementation of C/S CSC is in DOD Directive 7000.1.¹ Specific instructions for implementation, establishment of the criteria, definition of terms, and definition of the scope of application in DOD Instruction 7000.2.²

DOD Instruction 7000.2 was expanded and further clarified in a joint Army, Navy, and Air Force C/S CSC implementation guide.³ This guide contains very explicit guidance for grading a contractor's system, defining and explaining terms, and using methods of analysis. The system attempts to insure a common basis of comparison. If C/S CSC dictates anything to a contractor, it is his analysis of the data gathered and his form of presentation of that data.

III. APPLICABILITY

Application of C/S CSC criteria is oriented toward major acquisitions. DOD provides some latitude as to what "major acquisition" means. The definition of a major system is given in DOD Directive 5000.1 and is used as a guide for application to various DOD components. DOD 5000.1 establishes the following three criteria as requiring application of C/S CSC.

A. A system with estimated RDT&E cost of \$50 million and \$200 million in production (FY72 dollars).

B. A program of national urgency.

C. A program recommended by DOD component heads of Office of the Secretary of Defense (OSD) officials.

Further guidance in this area comes from Headquarters, Army Materiel Command (HQ/AMC, now DARCOM). DARCOM establishes a \$25 million RDT&E cost and \$100 million in production as a must level for application and \$10 million RDT&E as a likely level for application.

C/S CSC is intended to provide performance measurement and management visibility through the unpredictable period of a system or product's life. After this stage is completed, C/S CSC loses its real value. As a result, firm-fixed-price or firm-fixed-priced-with-escalation contracts are excluded.

IV. CRITERIA AND IMPLEMENTATION

There are thirty-five (35) criteria that fully require demonstration in the C/S CSC. The 35 criteria are contained in five major functional categories. The categories are:

- A. Planning and Budgeting
- B. Organization
- C. Accounting
- D. Analysis
- E. Revisions and Access to Data

These categories will be discussed in more detail in the following sections. Each criterion will not be included because of overlapping, duplicating themes (not in application), or not being germane to general systems engineering or technical management interest.

Since C/S CSC is a DoD level requirement, a DoD level of demonstration that a contractor's system meets the criteria is sufficient to qualify a contractor's system. This is accomplished by several methods. First, a contractor may win a major system contract that requires him to use and satisfy C/S CSC performance measuring system. This is the most common reason and method to gain a review. Second, indications may surface, through either government or contractor analysis, that there may be problems with a system. In this situation a re-evaluation may be warranted. The final reason for validation has increased greatly in the last few years: a contractor may request a review and evaluation of his system just to establish validity of his own internal system. Many contractors are applying the DoD approved system to their commercial and industrial projects because of the improved visibility provided. This type of request is in sharp contrast to the opposition encountered by C/S CSC in 1967 at its inception.

Once a contractor's system has been validated by any of the services or a DoD team, a Memorandum of Understanding (MOU) is generated. The MOU is then used by the contractor to provide certification of his system in any proposals he may make which require application of a C/S CSC approved system. The reference to the MOU normally satisfies the requirement and obviates the need for evaluation or demonstration reviews. The MOU, however, does not remove the need for surveillance to prevent deterioration of the contractor's

system. Reviews will be made with selective test cases and examination of internal practices to insure that valid data is still being obtained from the system.

V. CRITERIA DISCUSSION

The concept and functioning of C/S CSC revolve around the Work Breakdown Structure (WBS) of the item under contract. The WBS represents the hierarchical organization of a system. The major system under contract represents the first level of the structure. Each succeeding level represents a further breakdown of the system. The generation and maintenance of a WBS is defined in MIS-STD-881A.⁵ An example of a WBS to the third level for an aircraft system is shown in Figure 1. The example was extracted from MIL-STD-881A and shows only hardware type items. The complete WBS includes services and data which result from all project engineering efforts.

Only two things are essentially new or different about C/S CSC from management approaches of the past. One of these differences is the requirement that management controls must "play" together. This "playing" together requires the contractor to integrate his planning, scheduling, budgeting, work authorization, and cost accumulation systems with each other, with his WBS, and with his organizational structure. Without this integration, a contractor might plan his work according to the technical work to be done, accumulate his costs by organizational structure, and budget his work according to what funds are available. The other difference is the concept of "earned value", or budgeted cost for work performed. Previously a program manager could measure progress against a predetermined schedule and measure actual cost for work performed against a budget. The problem was determining what the cost should have been for progress obtained, or how much should have been spent for the progress obtained compared to what was actually spent.

The concept of earned value, coupled with the WBS as the integrating feature, forms the basis of the C/S CSC.

VI. PLANNING AND BUDGETING

Planning is probably the single most important ingredient in the success of a program. The C/S CSC "work packages" constitute the basic building blocks of a contractor's planning, controlling, and measuring the performance of his project. A work package is simply a lower level task or job to be performed by a specific organizational element.

Work packages should be of short time duration. This requirement is not intended to make contractors establish arbitrary cutoff points just to have short work packages. The work packages should be natural divisions of the actual work to be done. If work packages are long and exceed the length of reporting periods (usually monthly) an assessment of the work-in-progress is necessary. The longer the period of work-in-progress spans, the greater the resulting inaccuracies due to estimates as well as delaying of trouble signals if the estimates have been too optimistic.

Levels. The following is a summary work breakdown structure for an aircraft system:

| <u>Level 1</u> | <u>Level 2</u> | <u>Level 3</u> |
|-----------------|----------------|--------------------------|
| Aircraft system | | |
| | Air vehicle | |
| | | Airframe |
| | | Propulsion unit |
| | | Other propulsion |
| | | Communications |
| | | Navigation/guidance |
| | | Fire control |
| | | Penetration aids |
| | | Reconnaissance equipment |
| | | Automatic flight control |

Figure 1. Summary work breakdown structure.

A second building block of C/S CSC is the Level of Effort (LOE) activities. The LOE is normally measured with passage of time and not with completion of discrete pieces of work. LOE must be separate from work packages in order to avoid distorting measurements. LOE type activities should be kept to an absolute minimum.

Apportioned effort is a third building block that may be discrete or similar to LOE. It differs in that it is related to or dependent on other efforts in direct proportion. Quality assurance and other inspection functions that cannot be performed until a product is produced are an example of apportioned effort. The apportioned effort is required, as opposed to including it in a work package, because the performing organizations are different. Since the different organizations have separate cost reporting and budgeting channels, the work must be separated.

After the work packages are established and other efforts identified, budgets are allocated to each work package or effort. The budgets are the cost required to complete the work identified in the work package. The term used is Budgeted Cost for Work Performed (BCWP). LOE and apportioned effort are also budgeted.

Next, all efforts and work are scheduled in a time phased manner. This schedule forms the basis for "opening" or beginning a work package. The schedule of the budgeted work packages is then used to generate a "should-cost" time phased baseline, against which actual cost is compared and performance measured.

In budgeting, the program "management reserves" are identified. These reserves can be used to correct problems encountered due to either inadequate budgeting or unexpected work requirements. The full impact of the use of management reserves is not going to be covered here because it is a very complex set of reactions to the analysis of the problem, reserve levels, and procedures that are established within a company to deal with such situations.

The variances between budgeted and actual cost that warrant analysis and management action are defined during this stage of the project. More will be said on the variance analysis in the analysis section.

VII. ORGANIZATION

The contractor's functional organization will be integrated with the WBS for the project. The work to be performed is assigned to the organizations responsible for the accomplishment of that work. Subcontracts are defined and assigned to responsible organizations, as are work packages. The performing organization should have considerable say in defining work packages and requesting or proposing a budget..

The level of the organization at which actual costs and budgeted costs are compared is established as a cost account. This is a natural control point and should be formed where the WBS and the contractor's cost elements intersect. At this level, indirect costs are applied and controlled, and the ultimate responsibility is assigned for accomplishing a work package.

VIII. ACCOUNTING

The accounting criteria require that the accounting system be formal, consistent, and in accordance with procedures established by the Defense Contracts Audit Agency (DCAA). This includes methods for applying overhead, applying materials costs, and identifying other hardware items to be charged against the project.

The accounting system must also be responsive to establishing rules for apportioning work in progress and consistent in applying earned value to the work completed.

Other than corrections for normal accounting errors, there will be no retroactive cost applied to any cost account. The system must also insure that actual costs are applied to the proper cost account.

IX. ANALYSIS

The cost account level is where the first analysis is performed. The analysis is carried out on a monthly basis. The actual WBS level where this is accomplished is defined in the contract. The analysis is carried to each higher level to determine the total status of the contract.

The analysis of the Budgeted Cost for Work Scheduled (BCWS) is compared to the analysis of the Budgeted Cost for Work Performed (BCWP). If the dollars scheduled to be spent for work are greater than the dollars actually spent for work, this would indicate a cost underrun. This situation would indicate a negative variance between scheduled expenditures and the earned value, or a diversion from work planned.

Another analysis is the comparison of the BCWP and the Actual Cost of Work Performed (ACWP) analyses. A negative variance here would indicate a cost overrun because the actual cost would have exceeded the planned cost.

It is at this stage that the need for the short work package concept becomes most apparent and subjectivity is taken out of the process.

The reporting process is the most formally defined C/S CSC requirement. These requirements are delineated in DoD Inst. 7000.10.⁶ The variances and reasons for the variances are shown, along with management actions to correct problems.

The contractor must also generate an estimated cost of completion (ECC) for the project. This estimate consists of all the actual costs-to-date plus the estimated costs for all remaining work. The ECC is then reconciled with the actual funds programmed to complete the project. The differences indicate the on-target, overrun, or underrun potential.

An example of the reporting format is shown in Figure 2. This figure is extracted from Inst. 7000.10.⁶

| CONTRACTOR | | COST/SCHEDULE STATUS REPORT | | | DEPARTMENT, TITLE & DATE | | FORM APPROVED OMB NUMBER | |
|--|--|--|--|---|--------------------------|---------------|-------------------------------|----------|
| LOCATION | CONTRACT TYPE / NO. 1 | PROGRAM NAME/NUMBER | REPORT PERIOD: | | | 22R0327 | | |
| NOTE <input type="checkbox"/> | PRODUCTION <input type="checkbox"/> | | | | | | | |
| Contract Data | | | | | | | | |
| (1) ORIGINAL CONTRACT TARGET COST | (2) NEGOTIATED CONTRACT CHANGES | (3) CURRENT TARGET COST (1) + (2) | (4) ESTIMATED COST OF AUTHORIZED, UNPRICED WORK | (5) CONTRACT BUDGET BASELINE (3) + (4) | | | | |
| | | | | | | | | |
| Performance Data | | | | | | | | |
| WORK BREAKDOWN STRUCTURE | CUMULATIVE TO DATE | | | | | AT COMPLETION | | |
| | BUDGETED COST | | ACTUAL COST WORK PERFORMED | VARIANCE | | BUDGETED | LATEST REVISED ESTIMATE | VARIANCE |
| | Work Scheduled | Work Performed | | Schedule | Cost | | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| GEN AND ADMIN | | | | | | | | |
| UNDISTRIBUTED BUDGET | | | | | | | | |
| MANAGEMENT RESERVE | | | | | | | | |
| TOTAL | | | | | | | | |

Figure 2. Sample cost/schedule status report

X. REVISION AND ACCESS TO DATA

As stated earlier, there are to be no retroactive changes. Any changes that are made should be on a tightly controlled basis. Internal changes to the budgeted baseline may become necessary in order to maintain a valid basis of comparison. When making these changes:

- A. The contracting officer must be notified.
- B. Work responsibility should not be transferred without transferring the associated budget.
- C. A budget assigned to one work package cannot be used to perform another task.
- D. When management reserves are used, it must be clearly indicated when and where they are applied.

Other changes may be required because of a Government required contractual change. When these changes are based on negotiated changes, the revisions will be made on the negotiated cost. Where work is authorized prior to negotiated changes, reprogramming will be carried out with the contractor's best estimate. Budgets for work not yet begun or completed may be altered after negotiation to reflect differences. Retroactive changes to completed work will not be made unless both contracting parties agree to each change.

Reporting of data is normally to the third level of the WBS (cost account level). All data will be accessible to the contracting officer or his representative.

XI. SUMMARY

The C/S CSC is an effective management control and performance measurement system. Difficulties arise due to reluctance of both government and contractor employees to utilize the criteria. It is not a substitute for good, imaginative management practices, but it is an effective tool when used to maximum advantage.

The use of the criteria is continually improving the contractor's ability to generate meaningful work packages. In addition, improvements are expected in the area of analysis.

REFERENCES

1. DoD Directive 700.1, "Resource Management Systems of the Department of Defense," 22 Aug 66.
2. DoD Instruction 7000.2, "Performance Measurement for Selected Acquisitions," 25 Apr 72.
3. AFSCP/AFLCP 173-5, AMCP 37-5, NAVMAT P5240, "Cost/Schedule Control System Criteria Joint Implementation Guide," 31 Mar 72.
4. DoD Directive 5000.1, "Acquisition of Major Defense Systems," 13 Jul 71.
5. MIL-STD-881A, "Work Breakdown Structures for Defense Materiel Items," 25 Apr 75.
6. DoD Instruction 7000-10, "Contract Cost Performance, Fund Status and Cost/Schedule Status Reports," 6 Aug 74.

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